Farnell

FG3 FUNCTION GENERATOR

INSTRUCTION BOOK

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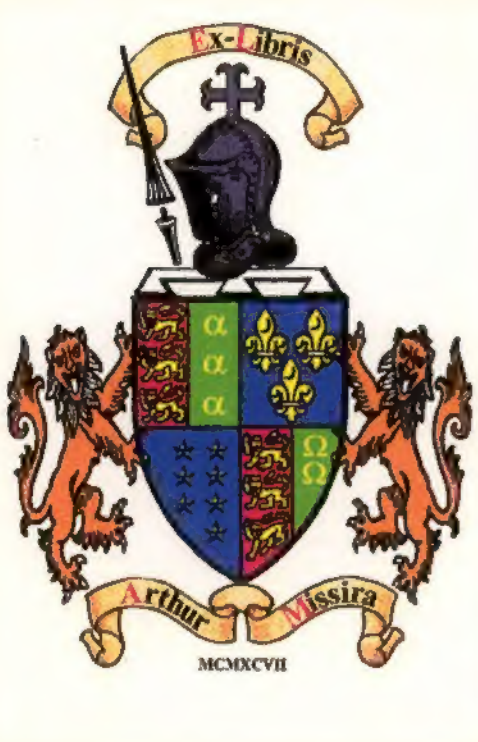
FG3 FUNCTION GENERATOR

FARNELL INSTRUMENTS LIMITED, SANDBECK WAY, WETHERBY LS22 4DH, YORKSHIRE



Price £1.00

Issue No. 1 6-77

CONTENTS

SCHEDULE OF EQUIPMENT

The instrument has been carefully packed to prevent damage in transit. When removing the unit from the box, be sure to remove all parts and accessories from the packing material.

The complete equipment comprises:-

a) 1 off FG3

b) 2 off 2mm plug

c) 1 off Instruction book

NOTE: In the event of damage in transit or shortage in delivery, separate notices in writing should be given to both the carriers and Farnell Instruments Ltd., within three days of receipt of the goods, followed by a complete claim within five days. All goods which are the subject of any claim for damage in transit or shortage in delivery should be preserved intact as delivered, for a period of seven days after making the claim, pending inspection or instructions from Farnell Instruments Ltd. or an agent of this company.

INTRODUCTION

The Farnell FG3 function generator is a mains operated instrument providing sine, square and triangular waveforms.

These waveforms are derived from a common oscillator extending from 0.02Hz to 200kHz in five switched decade ranges with provision for extending the lower frequency to .002Hz. The dial spans three decades and is calibrated with both logarithmic (log.) and linear (lin.) scales.

Internal log. or lin. sweep is provided by a separate oscillator having a fixed period of approximately 8mS. The sweep width is adjustable from approximately 20:1 to 1000:1 by means of a back panel mounted preset control and the sweep period may be extented by the addition of a non-polarised capacitor to the back panel.

The FG3 can also be swept by an external voltage source applied to the 'V.C.O. IN' terminal.

The output amplifier provides an adjustable output of 100mV to 12V pk to pk into a load of 600Ω from a source impedance of 60Ω. The desired waveform is selected by push button.

Low level outputs of T.T.L. compatible, triangle and linear sweep are also available (See specification).

SPECIFICATION

FREQUENCY RANGE	0.02Hz to 200kHz in five decade ranges using three push buttons and dial Extendible down to 0.002Hz by inserting a 10μF non-polarised capacitor into rear panel sockets (2mm) marked 'EXT FREQ CAP' *Note; lowest calibration on linear scale is 0.5Hz.*
DIAL ACCURACY	±5% of range maximum for linear dial. The log dial accuracy is unspecified
MAIN OUTPUT WAVEFORMS	Sine, square or triangle selected by two push buttons
MAIN OUTPUT AMPLITUDE	100mV to 12V peak to peak into 600Ω from 60Ω source
SINE WAVE DISTORTION	0.8% and not more than 2%, 5Hz to 200kHz over upper dial decade at 12V pk-pk into 600Ω. Distortion at frequencies below 5Hz unspecified.
FREQUENCY RESPONSE	Amplitude varies less than 2% from 0.02Hz to 20kHz " " " " 10% from 20kHz to 200kHz
CONSTANT LEVEL OUTPUTS	1) T.T.L. compatible 5V square wave (fan-out of 5 logic loads) available from 2mm socket on rear panel 2) Triangle waveform 2.5V pk-pk approx. Available from orange 2mm socket at rear in socket pair marked 'EXT FREQ CAP' 3) Linear sweep output ramp of 0 to 5V peak from a source impedance of 75Ω available from 4mm front panel socket. Min. load impedance 500Ω. Also duplicated at rear - orange 2mm socket of socket pair marked 'EXT SWEEP CAP'. This output may be used with a pen recorder.
SQUARE WAVE RISE and FALL TIMES	100nS and not worse than 200nS Measured at 12V pk-pk into 600Ω
DIAL AND SWEEP MODES	Linear or logarithmic, selected by front panel push button. Note that sweep always starts from LIN dial frequency and that the LOG dial covers 3 decades each occupying one third of dial rotation
SWEEP SPEED	8mS for 1:1000 variation The rate at which the frequency is swept may be slowed to as much as 30 seconds by the application of a capacitor to 2mm rear panel sockets marked 'EXT SWEEP CAP'. The capacitor must be a non-polarised low leakage type.
SWEEP WIDTH	1:1000 up from range minimum. This can be reduced to about 1:20 by adjusting a potentiometer marked 'SWEEP WIDTH' through a rear panel hole

VCO	0 to +10V external input to 4mm socket on front panel marked VCO will vary frequency from minimum to maximum range depending on dial setting. For f.m., set dial to required centre frequency and apply modulating signal to VCO input
OPERATING AMBIENT TEMPERATURE RANGE	0°C to 40°C
POWER SUPPLY	A.C. mains only. 50/60Hz. 190 to 260V or 95 to 130V by internal tap change. 8 watts max.
DIMENSIONS/WEIGHT (approx.)	Height 90 mm inc. feet Width 220 mm Depth 230 mm Weight 1.7 kg

Specification applies to a typical instrument at 20°C. We reserve the right to amend specifications without notification.

OPERATING INSTRUCTIONS

Installation

Check that the voltage range of the instrument supplied is suitable for the local mains supply. The instrument is normally supplied set for 190-260V operation. To convert to 95-130V operation, DISCONNECT from mains supply, remove bottom cover and protection shroud over the transformer. Unsolder yellow wire from 240V tap and resolder on to 115V tap. Leave red wire connected to 240V tap. Replace covers before reconnecting to mains supply.

The nominal a.c. input setting at the time of despatch from the factory is indicated on the back panel. If the setting is altered by the user he should amend the indication of input setting accordingly.

The three core mains lead must be connected as follows:-

Brown	-	Mains live
Blue	-	Mains neutral
Green/yellow	-	Earth (ground)

Operating instructions

Connect the mains lead to the supply and switch the FG3 on by depressing the 'Mains' push button. The 'On' neon indicator will illuminate.

Dial controlled oscillator

Select 'Dial' ('Sweep/Dial' button out). Select the desired frequency range by depressing the button marked for X1, X100, X10K or the two buttons marked for X10 or X1K as required. The required frequency may then be obtained by using the appropriate scale on the dial after selecting either log or linear mode. (Log mode is obtained by depressing the 'log/lin' button).

Sweep mode

To sweep the output frequency, depress the 'Sweep/Dial' button and select either log. or lin. mode with the appropriate position of the log/lin button, log mode being obtained by depressing the button. The frequency sweep will commence at the linear dial setting and will terminate at a point determined by the setting of the 'Sweep Width' control. This control is board mounted and can be adjusted by inserting a small screwdriver through the aperture in the back panel. The 'Sweep Width' control allows the frequency to be swept from about 20:1 to greater than 1000:1 from the range minimum.

The internal sweep speed of 8mS can be increased by the addition of a non-polarised capacitor to the 'external sweep cap' sockets. (See section 'Applications' for suitable values).

External voltage control of oscillator

The application of a voltage to the external V.C.O. socket controls the FG3 frequency in conjunction with the 'Dial'. Thus frequency modulation can be obtained by setting the dial to the desired frequency and supplying a modulating signal to the 'V.C.O. in' socket.

If it is required to control the oscillator by means of an external positive voltage only, the dial should be set to minimum.

Outputs

The amplitude available from the output terminal can be varied by the 'Amplitude' control. The scale around this control provides an indication of output voltage in volts pk-pk. The desired waveform - sine, triangle or square - can be selected by operation of the appropriate push buttons.

A fixed amplitude triangle wave of approx. 2.5V pk-pk can also be obtained from the orange 'Ext. Freq. cap' socket and is available irrespective of the output waveform selected.

A TTL compatible square wave can be obtained from the back panel socket. It is capable of driving 5 standard TTL loads.

The 'Sweep output' terminal on the front panel provides a nominal 5V positive going sweep ramp. The same output is also obtainable from the orange 'Ext. Sweep Cap' socket. This waveform can be utilised for X-Y plotting. (See 'Applications' section).

CIRCUIT DESCRIPTION

The circuit of the FG3 follows that conventional for function generators with IC3 used as the operational amplifier for the integrator which forms the heart of the basic waveform generating circuit. Switches SW3-5 are used to switch in different values of integrating capacitor, giving different frequency ranges. Current is alternately switched into and sunk from the input of the integrator which gives a sawtooth (triangular) waveform at the integrator output. The current is supplied from IC2, an 'operational transconductance amplifier', the inputs of which are switched alternately positive and negative so that the output appears alternately as a positive or negative constant current source of value equal to the input bias current (pin 5). The frequency of the output sawtooth is proportional to this input current. IC1 provides a current buffer amplifier with zero input impedance, P4 compensating zero offsets. For linear dial operation, linear sweep and external VCO the input of the amplifier is fed via a resistor, R9, R8 or R13, from either the dial potentiometer, the sweep ramp or the 'ext. VCO' socket respectively. P1 is used to adjust frequency to dial calibration. For logarithmic dial or sweep operation, the dial potentiometer output or sweep ramp are taken to VT1 and VT2 which form a linear to exponential converter employing the exponential relation between emitter current and base emitter voltage. The output current is fed to the buffer amplifier and is proportional to the exponent of input voltage. P3 adjusts the maximum current available from the circuit, while P17 is adjusted to give the current adherence to the dial log scale. SW1 and 2 are used to select the desired mode of operation.

The output of the integrator IC3 is fed to a Schmitt trigger circuit comprising VT4, 5 and 8. As the output ramps us, the Schmitt triggers at a point largely determined by the voltage at emitter VT8 which is adjustable by P8. As the output ramps down the circuit triggers back at a voltage largely determined by the current switched by VT4 and 5, adjustable by P6. The square wave output from the trigger is amplified by VT6, 7 and used to switch the current sources in IC2 thus maintaining the sawtooth oscillation. The square wave is also fed both to VT9 which provides a TTL compatible output, and the output amplifier, its offset being adjustable by P7.

The triangle wave output from the integrator as well as feeding the output amplifier selector is taken to a series of diode bridge circuits. The tops and bottoms of the triangular wave turn the diodes harder into conduction which rounds off the waveform into a simulated sinusoid. The degree of clipping is adjustable by P9, P10, P11 which are set to give minimum distortion.

The input to the output amplifier is selected by SW6 and 7 and amplified by VT13-18. VT13 and 14 form a differential amplifier, followed by high gain voltage amplifier VT15 with VT16 as constant current load. VT17 and VT18 provide a complementary emitter follower output, with R70 giving overall negative feedback. P15 adjusts the d.c. level of the output.

The sweep ramp oscillator employs IC5 as an integrator, R66 giving the input current, and VT11 and 12 form a Schmitt trigger which switches over when the ramp reaches approx. 6V, turning on VT10 which discharges the integrating capacitor C23, returning the ramp to zero. P13 is used to adjust the negative triggering point of the Schmitt for zero, P12 allows for rear panel adjustment of the sweep amplitude.

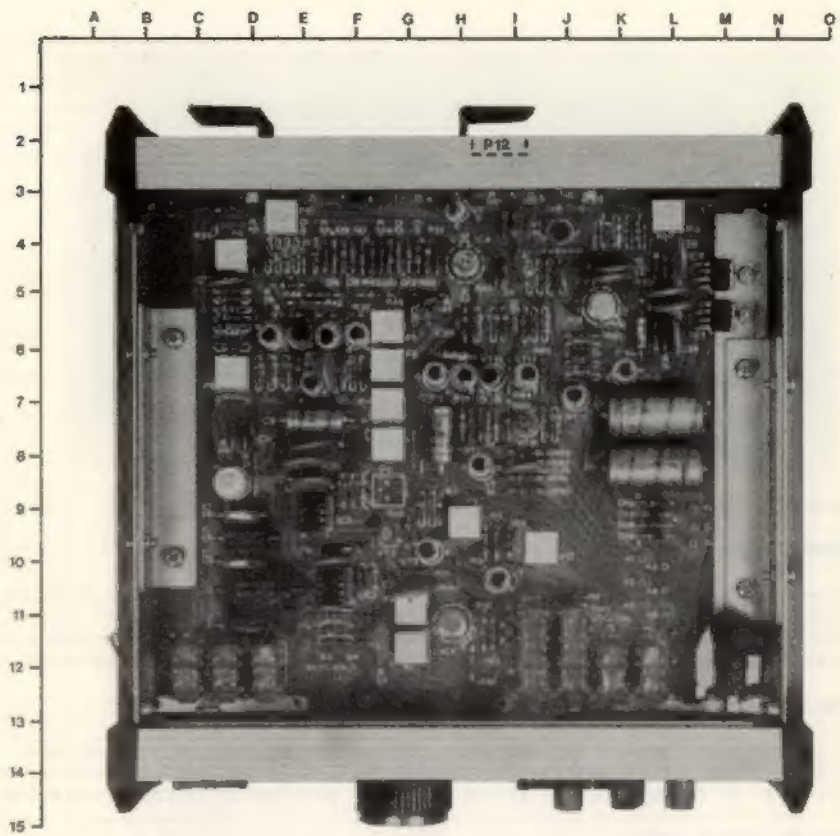
The power supply lines are derived from a full wave centre tapped bridge rectifier and are smoothed (C26, C27) and regulated by integrated circuit regulators IC6, IC7.

RECALIBRATION

It may be that after effecting repairs to active circuitry it becomes necessary to recalibrate the instrument. The following procedure should be followed:-

1. DIAL
   Check that frequency dial knob is tightened on potentiometer spindle such that the '1' mark on 'Lin.' dial is under the cursor when the resistance between potentiometer wiper and 0V line measures 45Ω ±5Ω.
2. POWER LINES
   Switch FG3 'On' and confirm that the neon is illuminated. Connect D.V.M. across C8, measure voltage (+12V ±0.6V).
3. Connect D.V.M. across C19, measure voltage (-12V ±0.6V).
4. MAIN OSCILLATOR SCHMITT TRIGGER
   Rotate frequency dial to max. frequency, set 'Log./Lin' switch to 'Lin', 'Dial/Sweep' switch to 'Dial' (i.e. buttons out) and range to x1k. Rotate P7 fully clockwise and connect scope to orange 'Ext. Freq. Cap' socket and earth, and confirm that a triangle wave is obtained. Use P6 to set the amplitude to 2.5V pk (±50mV) and P8 to centre the waveform about zero (±50mV).
5. SET FREQUENCY
   Set P3 fully anticlockwise (x1k range) rotate dial fully anticlockwise and adjust P4 for an oscillation frequency of less than 20Hz (say 2Hz) but greater than 0.
6. SET MAX. LINEAR
   Select 'Lin', x1k, dial at 20. Use P1 to give a frequency of 20.00kHz ±100Hz.
7. Select x10k use C15 to give a frequency of 200kHz ±1kHz.
8. SET MAX. LOGARITHMIC
   Select 'Log' (x1k) dial 20 (log scale) use P3 to set frequency to 20.00kHz ±100Hz.
9. Set dial to log 2 and adjust P17 for a frequency of 2.00kHz ±10Hz.
10. Set dial to log 0.02 adjust P4 (if necessary) to give a frequency of 20Hz ±1Hz (i.e. 50mS). Check that when on 'Lin' '0' frequency is less than 100Hz.
11. Recheck at 'Log' 20 and repeat 8, 9, 10 to obtain conformity within ±10%.
12. OUTPUT AMP. D.C. OFFSET
    Turn 'Amplitude' potentiometer fully anticlockwise, connect D.V.M. across output terminals, and adjust P15 to give 0 volts (±50mV).
13. Turn dial to max. frequency (x10k range), select 'Triangle'. Turn 'Amplitude' potentiometer fully clockwise and using scope confirm that a triangle wave of greater than 13.6V pk-pk is obtained.
14. SINE DISTORTION
    Select 'Sine' x100 and use P9, P10 and P11 to give a visually good sine wave.
15. Connect distortion analyser to output terminals and further adjust P9, P10 and P11 for minimum distortion.
16. SQUARE WAVE
    Reconnect scope and select square wave operation. Adjust P7 for symmetry about zero volts (±50mV).
17. Place 600Ω load on output and at max. frequency (200kHz) confirm that triangle/sine/square are all greater than 12V pk-pk and within ±0.6V of each other.
18. SWEEP
    Select 'Log', 'Sweep', x10k, 0.02 on dial 'Log' scale. Ensure P12 (Sweep Width) accessible through the back panel, is fully clockwise. Connect scope to sweep output terminals. Adjust P13 for 0V ±20mV at start of sweep.

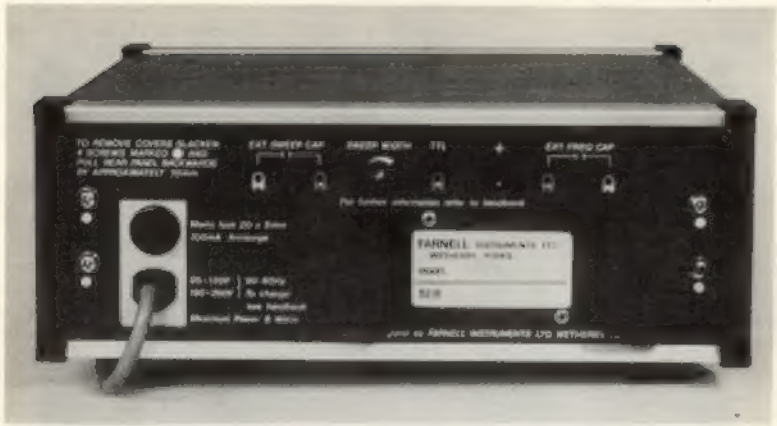
LOCATION OF COMPONENTS FOR RE-CALIBRATION



Component	Approx. location	Setting
C8	E7	+12V ±0.6V
C19	H7	-12V ±0.6V
P7	F5	Fully clockwise
P6	C6	2.5V ±50mV
P8	F6	±50mV about zero
P3	H9	anticlockwise
P4	G11	2Hz
P1	G12	20kHz ±100Hz
C15	C8	200kHz ±1kHz
P3	H9	Set log 20kHz
P17	I10	2kHz ± 10Hz

Component	Approx. location	Setting
P15	G8	0 volts ±50mV
P9	D4	For min distortion
P10	E3	
P11	G7	
P12	I2	
P13	L3	0 volts ±20mV

APPLICATIONS



RANGE EXTENSION

Frequency range

The lower frequency limit of 0.02Hz can be extended down a decade to 0.002Hz by the addition of a 10µF non-polarised, low leakage capacitor, (Polyester polycarbonate) to the 'Ext. Freq. Cap' sockets. The dial frequency accuracy can be maintained if the capacitor has a 1% tolerance and the x10k range is selected.

Sweep

The internal sweep time of 8mS per sweep typical can be increased by adding a capacitor to the 'Ext. Sweep Cap.' sockets. The desired value of capacitor, which should be a low leakage, non-polarised type, may be selected from the scale Fig. 1.

Setting the sweep width

If the sweep width control is set fully clockwise and the dial set to 0, the FG3 will sweep to approximately range maximum (1,000 x min. setting).

The frequency at which the sweep starts is determined by the 'Lin' dial setting even on log sweep. The 'Finish' frequency can be set by adjustment of the sweep width control. By adding a capacitor to the 'Ext. Sweep Cap' sockets the end frequency can be monitored on a scope or frequency counter. Suggested capacitor values are 1µF if viewing the range on a scope and 10µF if monitoring with a counter.

Fig. 1 CAPACITOR VALUES FOR ALTERNATIVE SWEEP TIMES

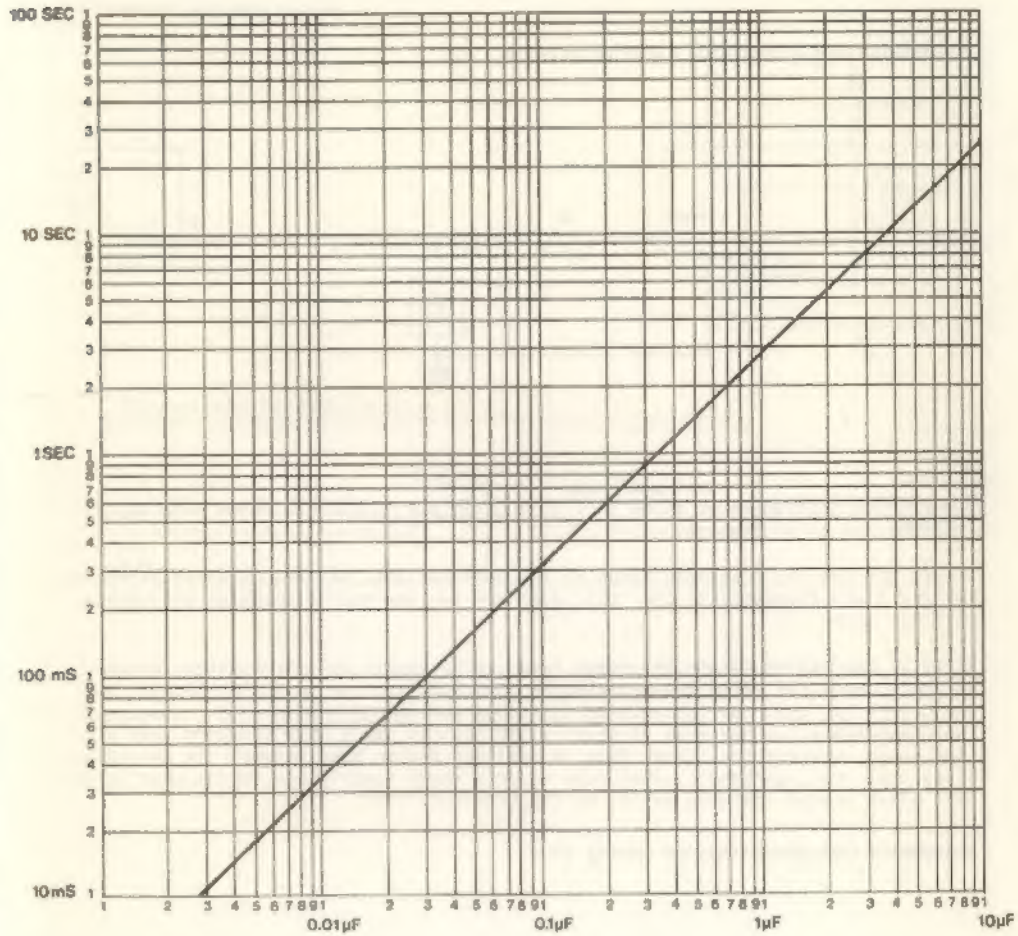
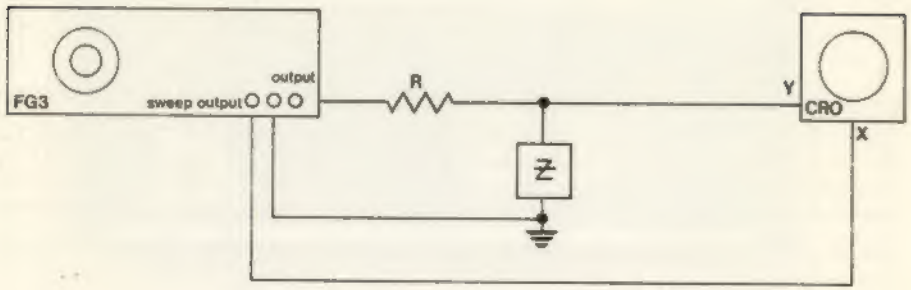


FIG. 1

Impedance characteristic of a passive network FIG.2



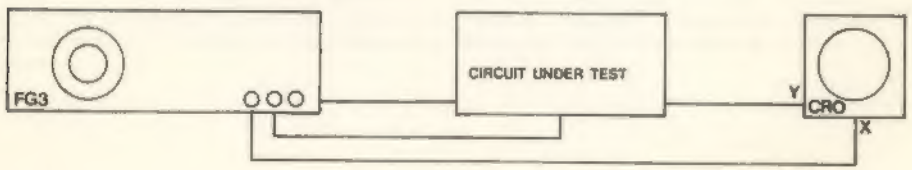
Connect the instrument as shown in Fig. 2 using a d.c. coupled scope with an 'X-Y' facility, or an XY plotter.

Select the desired frequency range by the push buttons, depress 'sweep/dial button set the start frequency on the 'Lin' dial and set the end of sweep by the method outlined above.

If it is desired to reduce the sweep speed particularly for the plotter then a suitable capacitor value may be selected from Fig.1.

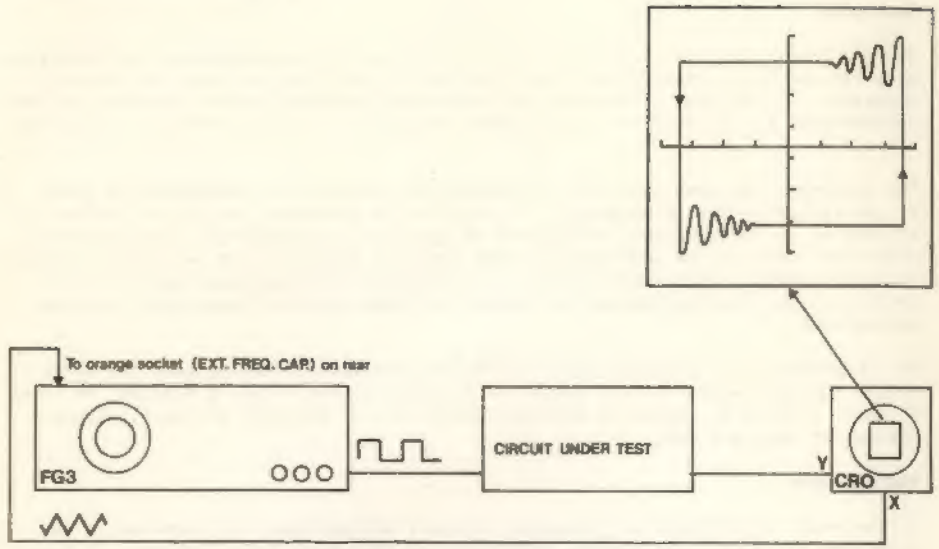
The 'Logarithmic' sweep mode is usually the most suitable when sweeping over a wide range, whereas the linear mode is best for narrow band sweeps. It should be noted that the logarithmic sweep mode is only truly logarithmic in law when using full width sweeps starting at '0' on the frequency dial.

Automatic frequency response testing FIG.3



Connect the instrument as shown in Fig. 3. Select the desired frequency. If the circuit is an audio amplifier then remember that a sweep width of 20Hz to 20kHz can be obtained on x1k range.

Transient response testing FIG.4



Connect the instrument as shown in Fig. 4. Select the desired frequency so that the response occupies the scope screen. The sweep time is $\frac{1}{2F}$ where F is the FG3 frequency. This then provides the scale for determining the rise and fall times.

MAINTENANCE

Guarantee

The equipment supplied by Farnell Instruments Ltd. is guaranteed against defective material and faulty manufacture for a period of twelve months from the date of despatch. In the case of material or components employed in the equipment but not manufactured by us, we allow the customer the period of any guarantee extended to us.

The equipment has been carefully inspected and submitted to comprehensive tests at the factory prior to despatch. If, within the guarantee period, any defect is discovered in the equipment in respect of material or workmanship and reasonably within our control, we undertake to make good the defect at our own expense subject to our standard conditions of sale. In exceptional circumstances and at the discretion of the Service Manager, a charge for labour and carriage costs incurred may be made.

Our responsibility is in all cases limited to the cost of making good the defect in the equipment itself. The guarantee does not extend to third parties, nor does it apply to defects caused by abnormal conditions of working, accident, misuse, neglect or wear and tear.

Maintenance

In the event of difficulty or apparent circuit malfunction, it is advisable to telephone (or telex) the Service Department or your local Sales Engineer or Agent (if overseas) for advice before attempting repairs.

For repairs and recalibration it is recommended that the complete instrument be returned to:-

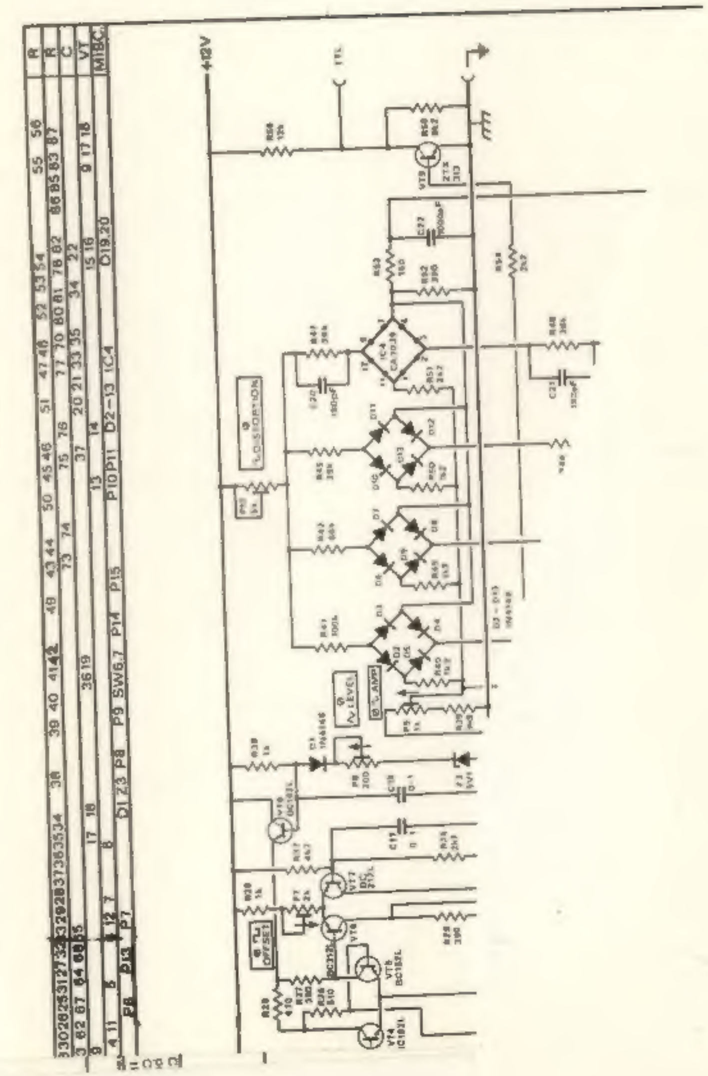
The Service Department,
Farnell Instruments Ltd.
Sandbeck Way,
Wetherby, West Yorkshire
LS22 4DH.

or

Tel: 0937 63541 Telex: 557294

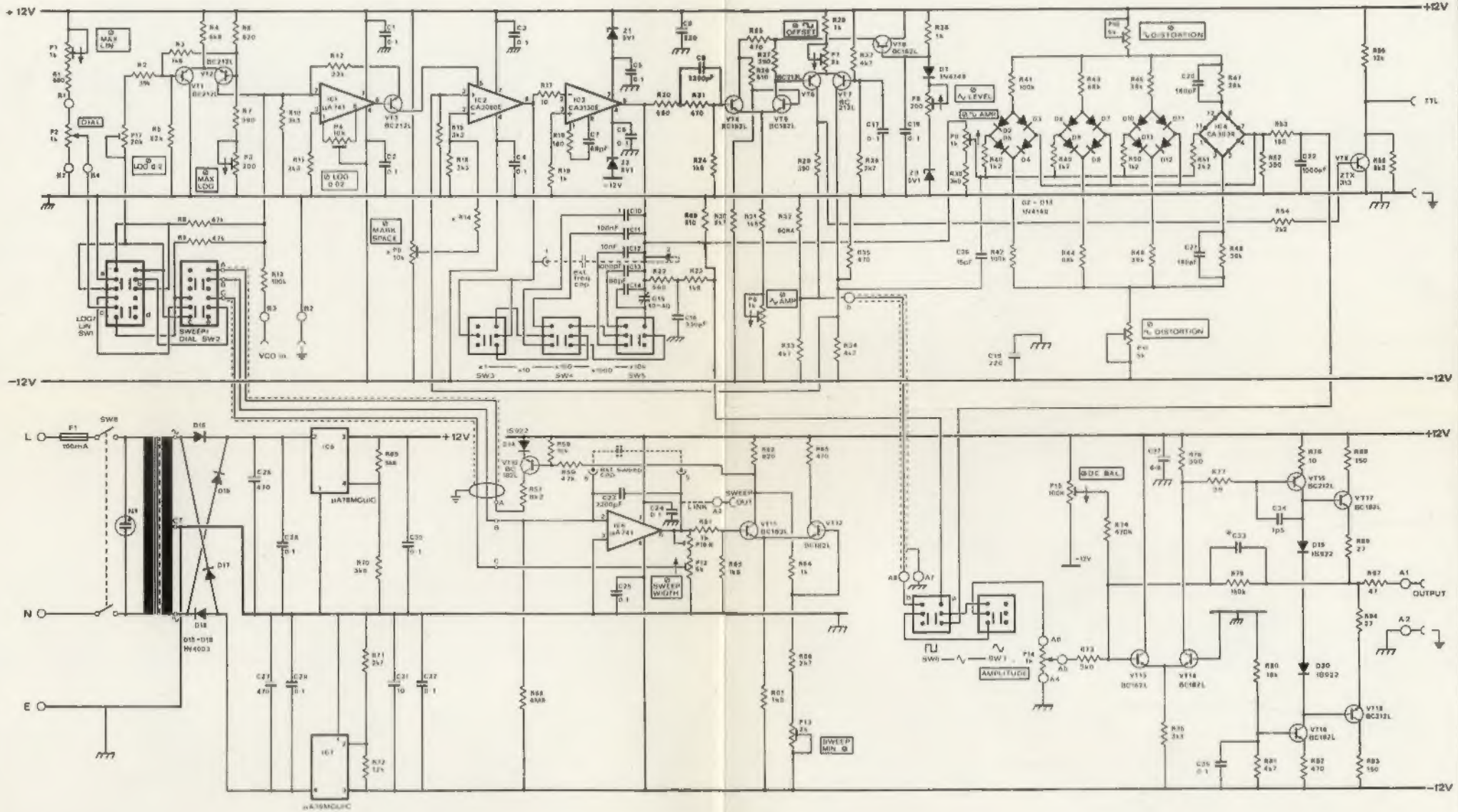
Please ensure adequate care is taken with packing and arrange insurance cover against transit damage or loss.

NOTES



DRG. No 1ZX0833105

R	1 2 5 3 4 8 9 6 7 13 10 11 12 15 16 14 17 18 19 20 22 21 23 24 28 30 26 25 31 27 32 33 29 28 37 36 35 34 38 39 40 41 42 49 43 44 50 45 46 51 47 48 52 53 54 55 56	R
R	69 70 71 72 57 66 58 59 61 63 62 67 64 60 65 73 74 75 76 77 70 80 81 78 82 86 85 83 87	R
C	1 2 30 31 32 3 4 7 23 5 6 10–15 24 25 16 8 9 17 18 36 19 37 20 21 33 35 34 22	C
VT	1 2 3 10 4 11 5 12 7 8 13 14 15 16 9 17 18	VT
MISC	P1,2 SW1/2/4 D15–18 P3 IC1 P4 IC6 IC7 P5 SW3/4/5 IC2 D14 IC3 Z1 Z2 IC5 P12 P6 P11 P7 D1 Z3 P8 P9 SW6,7 P14 P15 P10 P11 D2–13 IC4 D19,20	MISC



TRACD						
CHKD						
DRWn	B	2-6-77	Q4239/P			
DWG	ISS	DATE	MOD. No			
	A	30-3-77	-			

NOTE Resistor values given in Ω unless otherwise stated.
Capacitor .. .. μF .. ..
* Component not always fitted.
Push button shewn in button released position.
○ Solder pin

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

TITLE: CIRCUIT DIAGRAM

FG3

DRG. No 1ZX0833105

SHT. 1 OF 1 SHTS.

FARNELL INSTRUMENTS LIMITED · SANDBECK WAY · WETHERBY · YORKSHIRE LS22 4DH · TELEPHONE 0937 3541